

The Wireless Classroom & Deployment Planning Process

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The Choice of a Laptop Cart Solution

A Rationale

The integration of technology into the classroom has been an important topic for the past decade. During that time, schools and school districts have wrestled with a multitude of classroom configurations. Classroom configurations have ranged from the one-computer classroom, through the mini-lab (5 – 8 computers' classroom) not to mention the ever-popular computer lab.

The one-computer classroom has obvious pitfalls from its namesake alone. While it is true that one computer can be used to incorporate technology into the classroom, the single computer is generally used as a content research and delivery tool with limited student-to-computer access. Conversely, the computer lab offers the greatest student-to-computer access. Unfortunately, computer labs require taking the students to the technology. This method severely hampers the ability of students to embrace computer technology in their day-to-day learning activities.

By utilizing the "mini-lab" concept, educators are able to embrace and promote the infusion of computer technology into the learning process. Through grouping of students, scheduling computer time and planning projects that incorporate technology, the mini-lab becomes a viable and affordable option for many educational institutions. The mini-lab does possess its own set of challenges. Consider the following when planning a mini-lab deployment:

- Do the classrooms in your schools have enough floor space to house the computer furniture associated with a workstation mini-lab?
- Do the classrooms in your schools have enough electrical capacity to accommodate 5 to 8 desktop computer systems and all peripherals? Note: A system should include one network-capable printer.
- Do the classrooms in your schools have network infrastructure required to attach 5 to 8 computers plus a printer?

So, what does classroom computer Utopia look like? While technological strategic planners ponder that question, educators and stakeholders must look at current options to the hard-wired desktop PC. May we introduce the Wireless Classroom? This document will serve as a guide to assist in the planning and deployment of a wireless classroom.

Major topics include:

- **How to Deploy** (There is nothing worse than tripping out of the gate.)
- **Peripheral Equipment** (Integration requires more than computers.)
- **What has been forgotten?** (Thousands of dollars gather dust over a \$5.00 part.)
- **Avoiding Icebergs** (What problems lurk under the waterline, waiting to sink us?)
- **Training** (If you give them equipment...they may not know how to use it or support it.)
- **Curriculum** (What were we going to teach with these tools?)

Equipment Considerations

Once a school decides to deploy wireless laptop computers, the next task is to choose a model and its specifications. While this decision appears to be simple on the surface, it is quite complex. Decisions must be made in the areas of speed, RAM, hard drive capacity, CD ROM, DVD ROM, CDRW, batteries and finally which wireless standard will be used. It is also important to consider the rate at which your school or district adopts new software and

operating systems. Typically, school districts will use a computer for up to 5 years. During this same period, software developers release newer versions every 18 to 24 months.

The frequency at which chip manufacturers release new processors, makes it difficult to choose the appropriate processor speed of a computer. While it may not be financially feasible to purchase this week's fastest processor, it is necessary to purchase a processor that is more than capable of running this week's software plus the next version.

In addition to considering the speed of processor for a new operating system or application software, it is necessary to select the correct amount of RAM. Software developers offer minimum requirements for RAM. Think about these minimum specifications and the fact that the computer software may be upgraded before the end of its hardware life. Additionally, it is less expensive to purchase a computer with the necessary memory than it is to upgrade the machine when the machine is a few years old.

Hard drive capacity has dramatically increased over the past ten years. Keeping this in mind, and the fact that many school networks maintain network storage for their users, laptop hard drive capacity for data is no longer as critical. However, decision-makers must consider the storage requirements of all the possible software applications necessary to achieve the goals of the learning environment.

Decision-makers will also need to choose between CD ROM, DVD ROM or CDRW drives. Note: Some computer vendors may offer a DVD/CDRW drive. A number of cases can be made for why decision-makers should choose one device over another. However, the final decision should be made based on the objectives of the curriculum being facilitated with the computer.

Major advancements have been made in the field of batteries over the past several years. At the time of this writing, Lithium Ion batteries are currently the best on the market. Consult the computer manufactures for the best type of battery available.

Wireless... 802.11?

Arguably, the most important, and yet most complicated decision to make, to go to a wireless deployment is choosing the standard. Currently, the industry primarily uses two standards, the 802.11a and the 802.11b standards. While each standard is capable of sending and receiving data wirelessly, each operates on a different frequency with different levels of speed and range. This sub-topic addresses the differences between the two standards without overwhelming "Geek Speak".

The 802.11a standard operates at the 5 GHz frequencies sending data of up to 54 Mbps while the 802.11b standard operates at the 2.4 GHz frequencies sending data up to 11 Mbps. At first glance, the 802.11a standard is the best choice, except the increase in bandwidth comes with a significant loss in range. The 802.11a standard is limited to a distance up to 60 feet whereas the 802.11b standard has an effective range of up to 300 feet. Note: The environment where the Access Point is deployed will affect the actual range and throughput.

To assist in the decision-making process, stakeholders must consider how many students will be accessing this network along with what type of information they will be accessing. Consider using the 802.11a standard if:

- All students have a need for high-bandwidth applications, i.e., concurrent video, voice and image-rich PowerPoint presentations.
- The existing school contains a high number of Bluetooth devices, which operate on the 2.4 GHz frequencies.

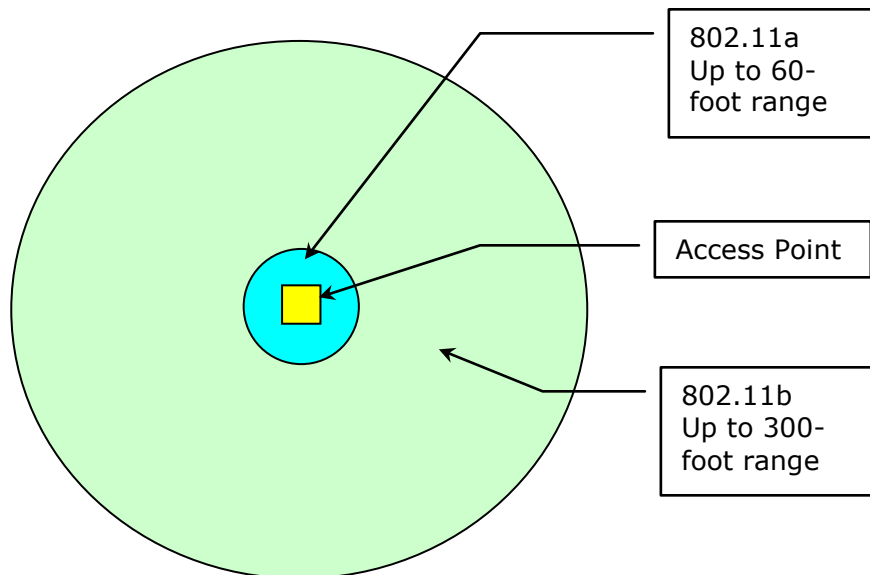
Consider using the 802.11b standard if:

- The range requirements are considerable; for example, school hallways, gymnasiums and outside common areas.
- The network has a substantial investment in 802.11b devices. Note: It is possible to convert many 802.11b devices to 802.11a; the cost associated with this conversion is prohibitive for schools.

If the intention is to only have students access the WLAN from the classroom, 802.11a standard with its increased throughput and shorter range, may be acceptable for your organizational needs. However, if the intention were anytime / anywhere access to the WLAN, the 802.11a standard with its shorter range would require a greater number of access points; therefore, the better choice for this need would be the 802.11b standard.

Standard	Frequency	Throughput (up to)	Range (up to)
802.11a	5.0 GHz	54 Mbps	60 feet
802.11b	2.4 GHz	11 Mbps	300 feet

A graphical view of 802.11 ranges



How to Deploy

As schools and school districts plan to deploy a wireless classroom solution, decision-makers must consider the complete system. Configuration decisions include:

- What type of wireless computer will be deployed?
- How many computers will be deployed in each classroom?
- How will wireless access points be deployed on the campus?
- How will network port capacity be increased on the campus?
- Does the school or district have a naming convention in place to support and manage additional computers, printers and wireless access points?

What type of computers should be chosen?

Option 1: Desktop computers with wireless access cards

Option 2: Wireless laptop computers on assigned desks

Option 3: Wireless laptop computers housed in lockable rolling carts

Each configuration option has unique benefits and challenges. Wireless desktop computers allow computers to be placed in a location conducive to the learning process rather than proximity to network access. This is also true for the wireless laptop computers deployed on an assigned desk. Each deployment has its own set of issues. For example:

- The classroom may not have the electrical capacity to support a mini-lab of computers. Additionally, the school building may require additional electrical lines to support these computers and supporting equipment.
- The classroom may not have the square-foot capacity to accommodate additional furniture needed for desktop computers or assigned laptop computers.
- The classroom's physical location may be less than secure.

Wireless laptop computers deployed in a rolling cart minimizes the necessity for additional electrical capacity as well as square-foot capacity of the classroom.

In the ideal classroom, each student would have his or her own wireless computer that was replaced annually with the best technology and software applications. The modern classroom is far from this ideal; therefore, it will be necessary for decision-makers to choose how many computers will be available for student use.

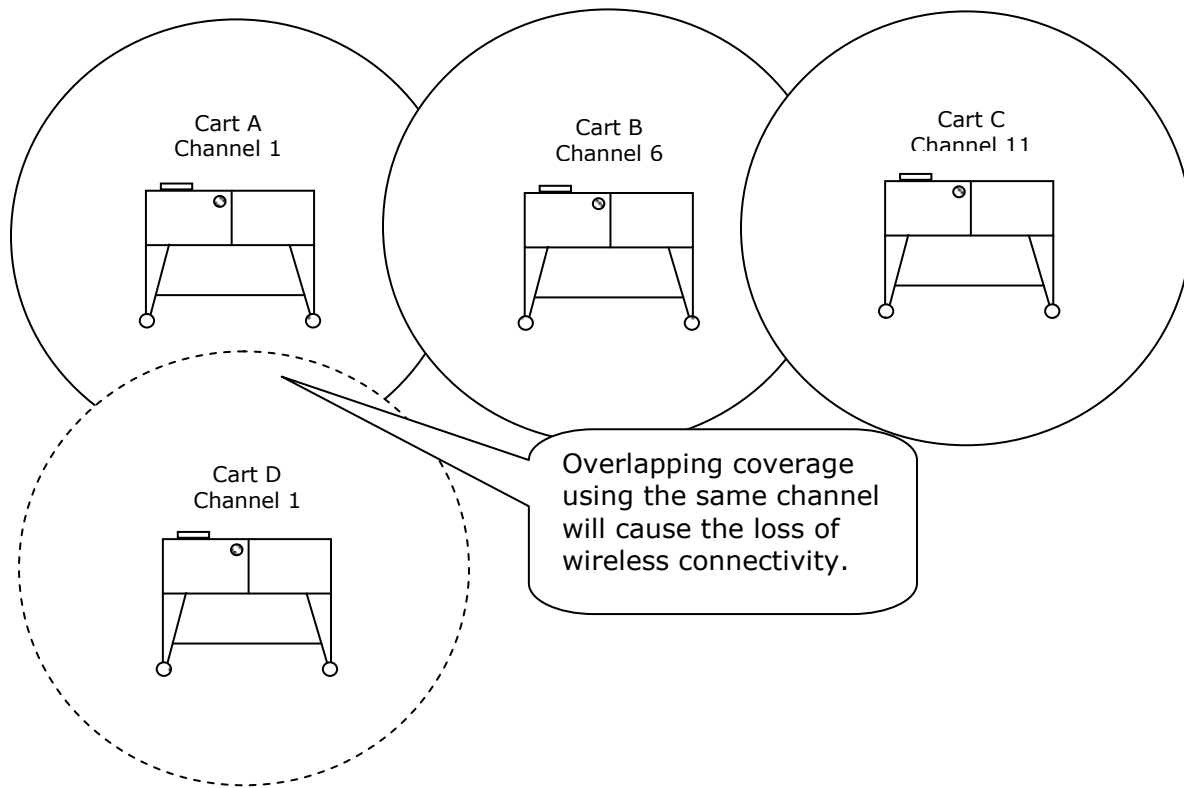
Over the past fifteen years, classrooms have seen the "one-computer classroom", the "six-computer" classroom, and variations through full-lab deployments. Success stories for each of these deployments are readily available thus making the decision of "What is the correct number of machines?" difficult. The underlying factor in each successful deployment has clearly defined goals and outcomes, along with adjustments to teaching methodology. Once the laptop program's goals and outcomes have been determined, selecting the correct number of computers to achieve these goals and outcomes will become apparent.

Determining the location of access points is imperative to a successful wireless solution. Furthermore, understanding the complexities of these systems is vital to the program's success.

(Geek Speak Alert – Please accept our apologies)

Consider the following: The 802.11 standard with its 11 channels can utilize full throughput with overlapping coverage areas. It is recommended that the channels be configured to differ by, for example, a school with an access point in every other classroom would set the first access point at channel 1, the next at channel 6 and the third at channel 11. This process seems rather basic until it is necessary to have multiple installations of each channel. Additionally, the wireless signal is not a flat plane, further complicating a deployment in a multi-story building.

School districts may choose to deploy a limited number of wireless carts in a school. In this scenario, the access point can be mounted directly to the cart thus minimizing the complications of overlapping channels. As additional laptop carts are added to the school, decision-makers must be attentive to the "three-cart rule." *Once three mobile laptop carts have been deployed on a campus, you must choose to either locate access points throughout the school or educate the staff on the complexities of 802.11 channels.* For example, If a school deploys laptop carts A, B and C using channels 1, 6 and 11 respectively. The additional laptop cart D, using channel 1, will cause problems if cart A and cart D are located near each other.



Before attempting to deploy a school-wide wireless LAN, it is highly recommended to hire a consultant firm to conduct a site survey and recommend technical details about the installation. At the completion of the survey, the school district should receive a final report including the following details:

1. A summary of the requirements from the initial preliminary work.
2. Estimated coverage areas based on the site survey measurements. This may be divided into areas with good coverage, marginal coverage, and weak coverage. It may also cite potential "trouble spots" of the signal strength.
3. A description of the locations of all access points, along with their configuration. Some elements of this configuration are the following:
 - Access point name
 - Access point channel
 - Access point coverage area
 - IP configuration
 - Antenna type and configuration (including direction for directional antennas)
 - Any other vendor-specific information
4. Recommendations for securing a wireless network.

Another concern waiting to snag a new deployment is existing network capacity. Classrooms may be equipped with one to five or possibly more network drops. The addition of a wireless cart will require network access for the access point, along with any other network equipment included in the deployment. For example, a classroom that has an existing workstation for the teacher requires one network drop, so the addition of a wireless cart with an access point, and printer will require two extra network drops. Decision-makers must choose whether the additional drops are added by pulling wire from the MDF/IDF or by adding a small Hub or Switch in the classroom or on the cart. Note:

Deploying access points school-wide can minimize the necessity for additional drops in the classroom.

The addition of any network equipment requires careful planning, and there should be thought given to the ability to track and manage new devices added during a wireless deployment. The district should have a device-naming policy or guideline in place that will enable IT managers to track where computers, printers and access points (including the SSID) are located on the network.

Lastly, thought should be given to the topic of recordkeeping. Documentation is critical in any network build-out. However, it is imperative to a wireless LAN because the network medium is invisible. Locating components cannot always be located by simply tracing cables. Documentation should include:

- Site survey report
- Annotated building blueprints with access point locations, names, and their associated coverage areas. If possible, the blueprints should also indicate areas of marginal or no coverage.
- A separate list of information about the access points in tabular form, which includes the location, name, channel, IP network information, and any other administrative information.

Peripheral Equipment

The prospect of adding wireless laptop computers to a classroom is an exciting prospect for the most experienced technology enthusiast; however, peripheral equipment can easily be overlooked. The most obvious peripheral to purchase for any computer system is a printer. However, other instructional peripherals, such as digital data projectors, document cameras, electronic white boards and classroom audio enhancement should be considered.

Where printers are concerned, school districts have two popular choices; the laser printer or the inkjet printer. Network administrators will choose network laser printers over stand-alone inkjet printers due to ease of deployment. Cost factors to consider when purchasing a printer should include "upfront" cost and operational cost. Laser printers have a higher "upfront" cost ranging from \$300.00 to well over \$1000.00; inkjet printers range from \$100.00 to \$300.00. Operational cost shows the true value of the laser printer. The duty cycle (volume of pages per month) is greater than that of an inkjet printer and the cost per page is less. The cost of printing with a laser printer will generally run pennies per page; inkjet printers can cost as much as 10 cents for black and white, and color printing can run as high as \$.20 per page.

When designing a classroom, a fundamental tool is the chalk or whiteboard. This tool is used to capture classroom thoughts and processes. As computers are added to the classroom, tools which are fundamental to an electronic classroom need to be introduced, including, digital data projectors, document camera and electronic whiteboards.

Teachers often need to demonstrate educational concepts, software, and access websites for the class. A gathering 30 student around a computer monitor or laptop monitor is ineffective. Digital scan converters allow the computer video signal to be sent to a television set. However, these devices tend to distort the images and text is often difficult to read. Digital data projectors allow information to be displayed in a larger viewing format. When choosing digital projectors, decision-makers must consider price, lumens (1000 or more),

Screen resolution SVGA (800 x 600) or XGA (1024 x 768). *Note: Many laptop computer displays are default set to 1024 x 768 therefore XGA projectors are needed. Lowering the laptop display resolution to 800 x 600 will allow SVGA projectors to be utilized.*

Document cameras allow teachers to place manipulatives, pictures and other non-digital items under the camera. The image of the object is displayed on the screen via the digital projector. Many document cameras allow the teacher to capture or zoom.

Electronic whiteboards and whiteboard capture devices have gained popularity in recent years. Electronic whiteboards connect to the computer and capture any data written on the board. This data may be saved, printed and even converted to HTML to be posted on the web. Adding a digital data projector to the equation will allow the teacher and students to interact with the computer while they are standing at the board. Recent years have seen the development of a capture device that will attach to any existing whiteboard. These devices provide many of the same features of the electronic whiteboards.

A final peripheral consideration is audio enhancement. Audio enhancement in the classroom consists of a wireless microphone, amplifier and speakers, allowing the teacher's voice to be reinforced at a level where students can better hear the teacher over normal classroom noises. This system also lessens the strain on the teacher's voice throughout the day.

Consider the above peripherals in conjunction with wireless laptop computers. Students have access to worldwide information. Students are able to compose and print their work. Using digital data projectors, students can see the information being displayed in the classroom. Adding the ability to amplify the teacher's voice so students can hear what is being taught will only enhance student learning and subsequently improves student achievement.

Additional Considerations

Deploying a mobile wireless classroom is an exciting project; nothing will stifle that excitement faster than frustrated students, teachers and administrators. What could possibly frustrate the group receiving this wonderful equipment? Deployment is being held up because there is no location to set up the equipment, or, worse is having the equipment sit dormant in the classroom for lack of a five-dollar part being ordered. What is forgotten is a list of possible items that should not be overlooked as wireless laptop computers are deployed. While this is not a definitive list, it will get the planning group thinking about these and other items necessary to a successful rollout.

- Ethernet Cables
Multiple Ethernet Cables are needed both for connecting the wireless cart to the classroom network drop and for connecting the access point and printers to the hub or switch.
- Crossover Cables
Some switches require the use of crossover Ethernet cables, which should be noted when specifying and ordering equipment.
- Furniture
Will additional furniture be needed to support this deployment? For example, if the deployment includes a digital data projector, will it require furniture on which it should sit?
- Storage

Some laptop computers come with removable floppy and CD Rom drives, which need to be stored in a safe location.

- **Power Cables**
It is a well-documented fact that electrical receptacles are never where they are needed.
- **Wire Protectors**
Electronic white board, data projectors and computer have various wire connections. Generally, these wires run across the floor and present a safety problem.
- **Carrying Cases**
If laptop computers are made available to take home, they should be carried in appropriate cases.
- **Setup Location**
Deploying mobile laptop computer carts require time-consuming setups; therefore, a location to unpack and image the computers, mount and set up printers, hub/switches and access points will be necessary.
- **Asset Management**
If these carts will be moved from classroom to classroom, someone needs to be responsible for keeping them in working condition, charged and sent to repair when needed.
- **Cart Security**
Since fully-loaded mobile laptop carts are heavy, concern should be given to where the carts will be placed when not in use.
- **Trash**
Depending on the number of computers and carts being deployed, disposing of the packing and shipping material can become problematic. Will additional trash receptacles be required?

Avoiding Icebergs

Once the Wireless Classroom has been deployed, there are still "icebergs" waiting for an opportunity "to sink" the project. Equipment failure should not jeopardize learning opportunities. Therefore, spare laptop computers and access points should be considered when equipment is ordered. The laptop should be reconfigured and ready to be deployed to limit the disruption of the learning process. Access to the network is paramount to a wireless classroom; spare access points should be configured and ready to be deployed.

Laptop batteries are considered to be consumable products. Since these will eventually require replacement, monies should be allocated for the purchase of replacement batteries.

A laptop computer, as with any computer solution, has a finite lifespan; a schedule for replacing these laptop computers should be created as part of the initial deployment plan.

Classroom Laptop Guidelines

Before the classroom laptops are deployed, schools and districts may decide to examine the policies or guidelines that exist for laptop computers. If no policies or guidelines are in place, they may want to see if these should be developed. Without some basic guidelines, laptops might be unavailable when needed, damage to equipment can occur, student

learning can be affected, and support requirements are likely to increase. These issues warrant some discussion here.

If laptop sets move from location to location, a guideline that delineates priority of use may be necessary. Guidelines for prioritizing laptop use can include: Project research, word processing, skill development, or assessment activities. Or, will laptop use be based upon "first come, first served"?

Other guideline considerations might include:

- Can individual units be taken from the group and used in other locations?
- Can units be checked out for home use?
- Are there any training requirements as conditions for use?
- Are there specific procedures for reporting problems?
- Who is responsible for costs associated with the laptops (batteries, repair, etc.)?
- Who is responsible for the asset management for the equipment?
- Are there specific extended vacation or end-of-year instructions?
- Are there specific security instructions?

Deciding if policies or guidelines are needed for the above, and then successfully developing and disseminating that information to the appropriate individuals, can have an influence on the overall success of the deployment.

Training

Overview

Although many schools have initiated aggressive training programs for students, staff, and technology support personnel, additional training is required when implementing a laptop program.

Issues of battery management, peripherals, machine care, wireless access points, and security can easily defeat a successful equipment deployment unless appropriate attention is given to training requirements.

Technology Support Personnel

Because wireless laptop access is a new technology for many schools and districts, technology support personnel will need to develop new skill sets to provide adequate support for these systems. Training in deployment of wireless access points, laptop network configuration, hardware and software management, and connections to projection devices and digital whiteboards will be required. The training sessions should include hands-on experiences and full "take-away" documentation provided. Further, including these support personnel in the initial setup and configuration of the laptops will certainly help in their understanding and resolving and subsequent technical.

If the institution does not have access to individuals capable of providing the necessary training, request that the vendor assist in locating an appropriate trainer. It would be helpful if this individual could also provide after-training support.

The technology support personnel also will need a single-point-of-contact to help them resolve issues that are beyond their scope of knowledge or control; i.e., network permissions, drive images, access points, etc.

Training of Teachers

Technology staff development for teachers frequently equates with application skills development. Teachers learn to create slide presentations, documents, or spreadsheets. They may even learn to enrich their current instruction with technology. As developing a new set of technology competencies, it will frequently be necessary for a teacher to redefine instructional strategies.

Understanding individual teachers' learning styles will help planning training session. Good training includes verbal explanation, visual presentation, and hands-on experiences. Staff development leaders frequently have a level of knowledge far beyond that of the participants; it is important that the training start at the participants comfort level.

Most classrooms will never have a laptop for every student. Instead, classrooms will have a specific student/computer ratio, commonly a 5:1 or 4:1 ratio. Consequently, many schools initiate differentiated learning as an instructional model. This model maximizes each student's growth by meeting each student where he or she is and helping the student to progress. Carol Ann Tomlinson, Associate Professor of Educational Leadership, Foundations and Policy at the Curry School of Education, defines differentiated instruction more simply. She believes that it is *...just shaking up the classroom so it's a better fit for more kids.* (Tomlinson, 1999)

Whether or not there is a new paradigm of instruction, teachers need to adjust instruction to accommodate more than one simultaneous instructional activity. Major changes in an instructional model will require extensive staff development. Too frequently, technology arrives in a classroom and the corresponding staff development consists of the words, "Here you go."

Instructional leaders can guide teachers through the process of analyzing a video or real-life model classroom, and follow this with the participants planning and demonstrating instructional units that integrate wireless laptops. Some schools have found the Intel "Teach to the Future" program an effective way to prepare teachers in integration design while, at the same time, furthering teachers' technology skills. Units of instruction include both the teacher and student materials, alignment to standards, and evaluation. During any good staff development, it is essential that teachers produce usable classroom materials.

While planning good teacher staff development may seem daunting, it becomes even more so when associated training teachers on the technical side of the equipment.

Teachers must be comfortable with equipment issues; i.e., battery management, equipment care and security, characteristics of wireless access. They must also know how to operate any peripheral equipment such as digital whiteboards, printers, swappable

drives, and projectors. Hands-on training on all equipment assigned to the classroom is essential. This training should take place far enough in advance of the deployment that teachers can consider the equipment's capabilities and limitations when they plan their classroom activities. As with training the technical staff, it is important that teacher training include providing full documentation of procedures and equipment operation.

From their classrooms, teachers should be able to immediately contact technical support personnel when necessary. Equipment failures become even more glaring in any technology-rich classroom. A school-budget reality is that frequently equipment dollars are more abundant than personnel dollars. It is important to find a resolution to this problem before the deployment. (Use "Student Interns" for support?) Approach all laptop staff development with the thought that teachers will need to teach those same skills to their students.

Technology that does not work is a disruption to the educational process.

Student Training

Student training, like teacher training, is best approached an understanding of different learning styles. While simple verbal explanations will work for some students, video presentations and hands-on activities will work better for others. Schools will find that equipment dollars and support dollars will stretch further if up-front training for students is comprehensive.

Because there will be simultaneous classroom activities, it is important that students be as "equipment-independent" as possible. Students who can be "technology leaders" should be identified. Teachers will find that these individuals provide an invaluable resource, and provide teachers with the opportunity to focus on more instructional activities and less on technical issues.

Students will also need to learn what information and application resources are available to them for their activities. These resources will include both those on the laptop and those available on the network. If a teacher has access to a computer lab, it might be more efficient to provide basic application training as whole-group instruction. The teacher then can embed more advanced skills in the classroom activity itself. Future activities would reinforce all skills.

Curriculum

Curriculum Considerations

Discussion of technology as an instructional tool will frequently use the following premise:

- *No two children are alike.*
- *No two children learn in the identical way.*
- *An enriched environment for one student is not necessarily enriched for another.*
- *In the classroom we should teach children to think for themselves.*

Marian Diamonds:
Professor of Neuroanatomy at Berkeley , 2002

Although curricular goals and standards might be the same for all students in a classroom, it is important that instruction allow for different learning styles. Technology gives teachers that ability. With technology, a teacher can vary not only **when** an activity takes place, but can also change **how** a student does the activity. The teacher can even completely change the activity for a student or a group of students.

For the teacher who is beginning to differentiate learning in the classroom, differentiation may begin by varying the content, processes or product for each group in the class. As the teacher becomes more proficient using these techniques, differentiation can occur at all 3 stages of the process for some students.

Priscilla Theroux, 2002

Teachers can use laptop computers to provide students a wide variety of content. That content can be applications, either available on the laptop or on the network, or the content can be available as an Internet resource. Most teachers think of web resources as being some form of "web page", but computer applications can also be delivered to laptops through an application service provider (ASP).

Arizona has recently initiated a statewide service to schools, which provides more than 200 standards-aligned computer applications to students both at school and home. This project may well serve as a model of how to "untrap" school technology and make it available to students outside the school day.

Because teachers can change content to match the abilities and learning styles of their students, technology also allows the teachers to easily track individual student progress to the performance-objective level. The "one-size-fits-all" chain can be broken.

Visual or written paper products certainly do not represent the wide range of possible products to demonstrate student learning. Most students spend the majority of their project time planning, researching, and preparing. They do not need constant access to a laptop. This makes groups of laptops effective, rather than one for each student. When the student is ready, the wireless laptop can go where the student is working.

While wireless laptops may have some performance limitations beyond those of hard-wired workstations, the performance is certainly far superior to a few years ago, and it is generally more than adequate for classroom use. Laptops are available with CD burners, DVD players, dual batteries, and other peripheral devices that also provide resources for student projects previously not possible. Students rapidly embrace these opportunities, with or without teacher guidance.

Laptops and Student Assessment

A constraint to classroom reform often occurs because students, teachers, and administrators receive student assessment results too slowly to change instruction. If several days or weeks occur before test results are available, how can a teacher adjust instruction to meet student needs? How can students change their behaviors?

Wireless laptops offer a change in assessment practices. It would seem reasonable that if technology is truly a tool for student learning, students should also be able to use that tool

for assessment. The assessments can give the same attention to individual learning styles as during the instruction. In effect, the assessment can be personalized to the learner.

With laptops, assessments can be frequent, and feedback immediate. Assessments can instruct as well as review. Students can monitor their own progress and even, to some degree, plan their future learning activities. Not all students require simultaneous access to the laptops; students have differing learning rates. They, therefore, will arrive at assessment points at different times. Assessments can even branch to new learning activities.

Classroom laptops also facilitate assessment through portfolio. Portfolios are valued as an assessment tool because they can better represent true classroom performance. Moreover, many teachers, educators, and researchers believe that portfolio assessments are more effective than "old-style" tests for actually measuring academic skills and making sound instructional decisions.

After a paper assessment, it is necessary to convert the test results to digital format before merging the results with other data for analysis. Further, teachers need results in one format, administrators another, and parents yet another. Having the results immediately available in digital format increases the opportunities to share information.

Make no mistake; the challenges of implementing laptop student assessments are real. These challenges include: costs of development; student account and assessment security; test validity; equity. Cooperation of students, school communities, government agencies, and vendors will be essential to any technology-based assessment implementation.

As with any other assessment tool, the telling factor will be whether the information provided by the assessment has value and ultimately improves student achievement.

Final Thoughts

While a wireless classroom laptop deployment presents numerous technical, support, staff development, curriculum, and student-use challenges, the potential for increasing student achievement and interest is very high. Few, if any, other instructional models can provide the tools to impact individual student learning as a technology-rich classroom. Marianne Handler (1995) of National-Louis University indicates that:

When thinking about best practice in the use of technology, one must carefully consider the possible uses of the computer within the classroom. These possible uses include using the computer:

- to teach the student.
- as a tool with which students can learn.
- as a tool to assist in the learning process.
- to develop open-ended exploratory experiences for the students

Beyond standard computer workstations, wireless classroom laptops offer flexibility. They promote effective instructional strategies. No longer does a teacher have to "send students down the hall" to fulfill students' learning needs.

While the paradigm shift to effectively use classroom technology may appear to be a challenge, it is good to remember that such a shift is an evolutionary process. Teachers are

at different points in their professional journey and need to be accommodated with quality staff-development and technical support as they make the necessary transitions. Just as a computer technician must learn new technologies as they appear, so is it necessary for a teacher to promote instructional change. In both scenarios, it is necessary for staff development activities and support mechanisms to be in place to achieve the desired results.

As a final thought, it is also important to remember that laptop technologies rapidly change. Current wireless laptop limitations of battery life, access speed, durability, and costs will probably even change during any multi-year deployment. Rapid technology change has challenged education for the previous three decades. Educators have responded with a resounding, "We know it will change, but we must engage students with technology now."

Keys to any successful deployment of classroom laptop computers are careful planning of equipment acquisition and installation, staff development, and technical support. All are manageable; success is probable and anticipated.

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Carol Ann Tomlinson is Associate Professor of Educational Leadership, Foundations and Policy at the Curry School of Education, University of Virginia, Charlottesville, VA 22903 (e-mail: cat3y@virginia.edu). She is the author of *The Differentiated Classroom: Responding to the Needs of All Learners* (ASCD, 1999).

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